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Competition, prices, and quality in the market for physician consultations

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Abstract
Prices for consultations with General Practitioners (GPs) in Australia are unregulated, and patients pay the difference between the price set by the GP and a fixed reimbursement from the national tax-funded Medicare insurance scheme. We construct a Vickrey-Salop model of GP price and quality competition and test its predictions using individual GP-level data on prices, the proportion of patients who are charged no out-of-pocket fee, average consultation length, and characteristics of the GPs, their practices and their local areas. We measure the competition to which the GP is exposed by the distance to other GP practices and allow for the endogeneity of GP location decisions with measures of area characteristics and area fixed-effects. Within areas, GPs with more distant competitors charge higher prices and a smaller proportion of their patients make no out-of-pocket payment. GPs with more distant competitors also have shorter consultations, though the effect is small and statistically insignificant.

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1 Introduction

Market structure may have important effects on healthcare costs, quality and access. The majority of studies in the literature have examined the effect of competition in hospital or insurance markets; there are few studies of the market for physician services (Gaynor and Town, 2011). In this paper we examine the effects of competition on the prices and quality of general practitioner (GP) consultations using rich GP level data from Australia.

In Australia patients pay a fee for each GP consultation. The fees that GPs charge are not regulated and GPs are free to price discriminate between patients. The national, tax financed, Medicare insurance scheme provides a subsidy for the cost of a consultation (the Medicare rebate). The patient pays the excess of the GP fee over the Medicare rebate and these out of pocket co-payments by patients cannot be covered by insurance. GPs can choose to 'bulk-bill' a patient, so that the patient pays nothing to the GP who claims the rebate direct from Medicare as full payment. Patients can consult any GP: there is no list system. In this context, the role of competition between GPs is a key mechanism that may influence GP pricing and quality. However, the effect of competition in healthcare markets remains an unresolved issue (Gaynor and Town, 2011; Gaynor et al., 2011; Gaynor et al., 2012).

We make two contributions. First, building on previous work (Gravelle 1999, Brekke et al 2010), we develop a model of GP price and quality discrimination under bulk-billing with free entry into GP markets. We use it to generate predictions about the effects of competition, as measured by distance between GPs, as a guide to our empirical analysis.

Second, we use within-area variation in prices and distance between GP practices, to identify the effects of competition. We use area fixed effects to control for all area-level variables that are unobserved and may influence prices and GP supply in an area. The areas we use have an average population of about 33,000, so that they are small enough to capture the locational preferences of GPs when choosing where to practice, but large enough to provide within-area variation in prices and distance between GP practices. Our distance measure of competitive pressure follows a strand in the industrial economics literature which emphasizes distance to nearby competitors as a determinant of prices (Alderighi and Piga, 2012; Thomadsen, 2005). Distance between firms has also been found to affect prices in studies of hospital competition (Gaynor and Vogt 2003). Our within-area approach contrasts with the previous literature which has sought to identify the effect of physician competition using variation in area level measures of competition, such as the number of physicians per head of area population. These area-level measures may be correlated with unobservable area demand or cost conditions that affect pricing behavior. In our models we can also control for a rich set of GP-level variables (including gender, experience, country of qualification, whether the GP is a partner or employee in their practice, and the size of their practice).

Our empirical findings are consistent with the predictions from our theoretical model. GPs whose rivals are further away, bulk-bill (charge zero copayment to) a smaller proportion of their patients and charge higher prices to those they do not bulk-bill. The effects of competition on bulk-billing and prices are stronger in areas of greater socio-economic advantage. Distance to other GP practices also reduces quality, though the effects are generally not statistically significant.

Our study contributes to hotly debated topic (Gaynor et al, 2012) of the effect of competition on health care provider behavior. It is also relevant for other health systems with unregulated physician prices. In the US, charging fees above the price reimbursed by the insurer is known as balance billing (Glazer and McGuire, 1993; McKnight, 2007) and is generally illegal for Medicare services or services under managed care plans. Balance billing is permitted for uninsured elective services or where patients visit providers who are not contracted to the same health plan as the patient (out-of-network services). It is also permitted in some provinces in Canada (Sullivan and Baranek, 2002). In France and Germany GPs can choose a contract that permits them to charge fees above the fixed insurance rebate (L'Haridon et al, 2008; Busse and Reisberg, 2004). In many developing countries out-of-pocket payments are often uncapped and insurance provides only limited financial protection, for example in China (Hu et al., 2008) and South Korea (Chun et al., 2009). Our results on the pricing and quality setting behavior of GPs provide a useful reference for policy work in these countries and in countries wishing to deregulate prices.

1.1 Related Literature

Studies including theoretical models of physician competition and pricing behaviour include Glazer and McGuire (1993), who use a two-firm Hotelling model to examine how prices, bulk-billing and quality vary with patient location. Savage and Jones (2004) model bulk-billing by monopolistically competitive GPs but do not examine the effects of an increase in the number of GPs. Brekke et al (2010) have a Vickrey-Salop circular city model with a fixed number of doctors and all patients facing the same price and quality. There is no patient insurance and so no possibility of bulk-billing. Gravelle (1999) examines price and quality in a Vickrey-Salop model and allows for entry by doctors, but does not consider bulk-billing.

In the first empirical study of prices and competition in physician markets, Pauly and Satterthwaite (1981) use data on 92 US metropolitan areas. After instrumenting for physician supply with measures of area attractiveness, they find that areas with more physicians per capita have lower prices. More recently, Bradford and Martin (2000) report that higher physician density (physicians per head of population) is associated with less profit sharing amongst physicians in group practices and lower prices. Schneider et al (2008) find that physician market concentration in California, measured by the Herfindahl Hirschman Index (HHI) is associated with higher prices. Gunning and Sickles (2012) adopt the Bresnahan (1989) structural approach with price and cost data to measure the competitiveness of physician markets and conclude that these markets, including a submarket for GPs, are not competitive.

There have been four area level studies of pricing by Australian GPs. Richardson et al (2006) use 1995 data on 187 Australian statistical sub-divisions and instrument GP supply with area socio-economic status and the supply of private schools. They report that areas with more GPs per capita have higher prices to patients who are not bulk-billed but also have a higher proportion of patients who are bulk-billed, so that the average price to all patients is unaffected by GP supply. Savage and Jones (2004) use a 1989/90-2000/01 panel of data for the eight Australian states. After controlling for state and year fixed effects, they find that increases in GPs per capita increase the proportion of patients who are bulk-billed. McCrae (2009) uses a panel of data from 1996-2003 on all 816 Australian Statistical Local Areas. After instrumenting GP supply with area characteristics, an increase in area GP supply is found to be associated with higher prices. In a recent study, Johar (2012) uses patient-level data to examine the relationship between prices and patient income. She finds that in areas with more GPs the effect of patient income on price is reduced.

2 Institutional setting

Medicare is Australia's national tax-financed universal health insurance scheme, which subsidises medical services provided by GPs and medical specialists outside of hospitals, pharmaceuticals, and provides around half of the funding for public hospitals with Australia's eight State and territory governments contributing the rest. GPs work in practices owned by GP partnerships or by companies. GP practices vary in size, from solo practices up to practices with around 10 GPs. Revenue is generated through fee-for-service for each consultation. The prices paid by patients are subsidised by Medicare and patients can claim back a fixed rebate from Medicare as set out in the Medicare Benefits Schedule (Australian Government, 2008). Different types of consultation (defined in terms of complexity and length) have different Medicare rebates. [1]

Although the Australian Medical Association (AMA) publishes a consultation fee guideline,[2] it is not binding on GPs and there is no government regulation of fees. GPs can price discriminate and are free to set prices in response to market conditions. Since consultations are personal services, there are no arbitrage constraints to prevent GPs setting different prices and providing consultations of differing lengths to different types of patient. In particular, they can bulk-bill a proportion of their patients, charging a zero co-payment. Medicare sets a higher rebate for GPs who bulk-bill children under 16 and those on low incomes who hold government concession cards. Approximately half of the population hold private health insurance but this can only be used to cover hospital, dentistry and allied health services, not co-payments to GPs.

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[1] The Medicare Benefits Schedule has four categories of consultation (Australian Government, 2008). Level A services are simple consultations with limited examination, for example a consultation for a tetanus immunisation. Level B consultations are more complex than Level A and include history taking, advice giving, ordering tests, formulation and implementation of a management plan. Level C consultations are more complex than level B and must last at least 20 minutes. Level D consultations are yet more complex and must last at least 40 minutes. In 2008, level B and C consultations accounted for 88.4% and 10.5% of consultations and levels A and D together accounted for just over 1%.

[2] The AMA List of Medical Services and Fees is available for AMA members online at (https://ama.com.au/policy/doctors-fees).

Australia has no enrolment of patients or list system, and so patients can choose to visit any GP practice. GPs are gatekeepers to specialist and hospital services, though patients can access hospital services directly through emergency departments which can substitute for GP services. For GPs, there are no restrictions on geographical location of practice, apart from doctors arriving from overseas who must first practice for a set period in under-doctored rural areas. GPs in rural areas are eligible for a range of additional payments to encourage them to locate and remain in these areas. These issues do not affect our data which are for GPs in metropolitan areas.

3 A model of bulk-billing, price and quality

3.1 Specification

We examine the effect of competition on GPs' decisions by extending the Vickrey-Salop model of monopolistically competitive firms (Vickrey, 1964; Salop, 1979) to include choice of quality as well as prices. We also allow for the possibility that GPs bulk-bill (ie charge a price equal to the Medicare rebate) for a proportion of their patients.

Under the Medicare system the GP receives a gross fee per consultation of $p + m$, the patient reclaims the rebate m from Medicare and pays a net price of p.[3] Each patient demands at most one consultation per period and the utility gain from a consultation at GP j is

$$u_j = r - p_j + \alpha q_j - td_j \tag{1}$$

where p_j is the price the patient pays at GP j, q_j is the quality of the consultation (measured by its length), d_j is the distance to the GP, $\alpha \in [\alpha_0, \alpha_1]$ and t are taste parameters. We assume that r is large enough to ensure that the market is covered: all patients demand a consultation. All patients have the same marginal distance cost t. They differ in their marginal valuation of

[3] Strictly, the amount the patient can reclaim from Medicare is the minimum of the gross price and the Medicare rebate limit m: $\min\{p+m, m\}$. Thus the net amount paid by the patient is $p+m - \min\{p+m,m\} = p - \min\{p,0\} = max\{p,0\}$. This implies that it can never be optimal for the GP to set $p < 0$. Increasing p to 0 would have no effect on demand, since the net amount paid by the patient is unchanged, and so would increase revenue with no change in cost. Hence, the net amount paid by the patient is $max\{p,0\} = p$. Without loss of generality we impose the constraint $p \geq 0$ in the GP's profit maximisation problem below.

quality (α). If instead patients had different travel costs t the model would yield similar predictions, with patients with higher travel costs, who are less willing to shop around, being set higher prices and offered lower quality.

There are H patients in total in the market, distributed uniformly around the circular market of length L, so that the density of patients at any point in the market is $h = H/L$. The probability distribution and density functions of patient types, $F(\alpha;\theta)$ and $f(\alpha;\theta)$, are independent of location within the market, so that at each point there are $hf(\alpha;\theta)$ patients of type α. The parameter θ shifts the patient type distribution. We assume that $F_\theta < 0$ so that markets with higher θ have a larger mean valuations of quality.

There are G GPs equally spaced around the market so that the distance between GPs is $\ell = L/G$. GPs observe patient types i.e. their taste for quality. There are no legal restrictions on their pricing decisions. Since GPs are selling a personal service there is no problem with arbitrage if they set different prices or provide different length consultations to different patients. We therefore assume that a GP can sets prices and qualities which can differ according the patient's taste for quality α.

The demand for GP j from type α patients depends on the price $p_j(\alpha)$ she charges them and the quality $q_j(\alpha)$ she provides, as well as the prices and qualities of her immediately neighbouring GPs:[4]

$$
\begin{aligned}
D_j &= \frac{hf(\alpha;\theta)}{2t}\left\{p_{j+1}(\alpha) - p_j(\alpha) + \alpha[q_j(\alpha) - q_{j+1}(\alpha)] + t\ell\right\} \\
&\qquad + \frac{hf(\alpha;\theta)}{2t}\left\{p_{j-1}(\alpha) - p_j(\alpha) + \alpha[q_j(\alpha) - q_{j-1}(\alpha)] + t\ell\right\} \\
&= D_j(p_j(\alpha), q_j(\alpha); p_{j+1}(\alpha), q_{j+1}(\alpha), p_{j-1}(\alpha), q_{j-1}(\alpha), \alpha, \ell, h, \theta) \qquad (2)
\end{aligned}
$$

where the first term is demand from patients between GP j and GP $j + 1$ and the second is demand from patients between GP j and GP $j - 1$. The average variable cost of serving patients who get quality q is $\frac{1}{2}\delta q^2$.[5]

[4] See Gravelle (1999), Brekke et al (2010).

[5] One set of reasonable assumptions implying this cost function is that that the cost of GP time is linear, and the quality of consultation increases with GP time (consultation length) but at a decreasing rate. For example, with

GP j's profit is

$$\pi^j = \int_{\alpha_0}^{\alpha_1}\left[p_j(\alpha)+m-\tfrac{1}{2}\delta q_j(\alpha)^2\right]D_j(p_j(\alpha),q_j(\alpha);\cdot)f(\alpha;\theta)d\alpha$$

$$= \int_{\alpha_0}^{\alpha_1}\pi\left(p_j(\alpha),q_j(\alpha);\cdot\right)f(\alpha;\theta)d\alpha \tag{3}$$

Given that the profit function is separable across patient types, the GP chooses $p_j(\alpha)$, and $q_j(\alpha)$ to maximises $\pi(p_j(\alpha),q_j(\alpha);\cdot)$, subject to the constraint that $p_j(\alpha) \geq 0$.[6] The first order conditions are

$$\pi^j_{p_j(\alpha)} = D_j(p_j(\alpha),q_j(\alpha);\cdot) - \left[p_j(\alpha)+m-\tfrac{1}{2}\delta q_j(\alpha)^2\right]hf(\alpha;\theta)t^{-1} \leq 0\,,$$

$$p_j(\alpha)\geq 0, \quad p_j(\alpha)\pi^j_{q_j(\alpha)} = 0 \tag{4}$$

$$\pi^j_{q_j(\alpha)} = -\delta q_j(\alpha)D_j(p_j(\alpha),q_j(\alpha);\cdot) + \left[p_j(\alpha)+m-\tfrac{1}{2}\delta q_j(\alpha)^2\right]\alpha hf(\alpha;\theta)t^{-1} = 0 \tag{5}$$

where $\pi^j_{p_j(\alpha)}, \pi^j_{q_j(\alpha)}$ are the partial derivatives of π^j with respect to $p_j(\alpha)$, and $q_j(\alpha)$.

With identical GPs, the Nash equilibrium has all GPs choosing the same price and quality for each type of patient (α). Dropping the GP subscript, at the equilibrium each GP has $D(p(\alpha),q(\alpha);\cdot) = hf(\alpha;\theta)\ell$ patients of type α

Consider first the price charged to those patients who face a positive price $p(\alpha) > 0$. Substituting $hf(\alpha;\theta)\ell$ for $D(p(\alpha), q(\alpha);\cdot)$ in (4) we get $p(\alpha) = \ell t + \frac{1}{2}\delta q(\alpha)^2 - m$. For patients facing a positive price we can substitute this expression in the first order condition (5) for quality to get $q(\alpha) = \alpha\delta^{-1}$. Substituting this back into the expression for the price gives $p(\alpha) = \ell t + \alpha^2(2\delta)^{-1} - m$ for patients who face a positive price. This expression is increasing in α. Let α^p = denote the threshold level of α satisfying $p(\alpha) = \ell t + \alpha^2(2\delta)^{-1} - m = 0$, so that $\alpha^p = \left[2\delta(m-t\ell)\right]^{\frac{1}{2}}$. All patients with a taste for quality less than α^p, are charged a zero price. For these patients we must solve the quadratic first order condition (5) to determine quality.

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z denoting the length of the consultation and ω the constant marginal cost of consultation time, if the quality of a consultation is $q = \gamma z^{\frac{1}{2}}$, then cost per consultation of quality q is $\delta q^2/2$, where $\delta \equiv 2\omega/\gamma^2$.

[6] See footnote 3 which demonstrates that this constraint is without loss of generality

Thus the symmetric Nash equilibrium prices and qualities for patients vary with their quality taste parameter according to

$$p^b(\alpha;\ell,t,m,\delta)=0,\qquad q^b=q^b(\alpha;\ell,t,m,\delta)=\frac{\left[(\delta\ell t)^2+2\alpha^2\delta m\right]^{\frac{1}{2}}-\delta\ell t}{\alpha\delta},\ \alpha\le\alpha^b \tag{6}$$

$$p^{nb}(\alpha;\ell,t,m,\delta)=t\ell+\frac{\alpha^2}{2\delta}-m>0,\qquad q^{nb}=q^{nb}(\alpha;\ell,t,m,\delta)=\frac{\alpha}{\delta},\qquad \alpha>\alpha^b \tag{7}$$

$$\alpha^b=\alpha^b(\ell,t,m,\delta)=\left[2\delta(m-t\ell)\right]^{\frac{1}{2}} \tag{8}$$

and the proportion of patients who are bulk-billed is

$$F^b=\int_{\alpha_0}^{\alpha^b(\ell,t,m,\delta)}dF(\alpha;\theta)d\alpha=F\left(\alpha^b(\ell,t,m,\delta);\theta\right) \tag{9}$$

Irrespective of whether they are bulk-billed or not, patients with higher marginal valuations (α) of quality will receive higher quality.[7] A given increase in quality will generate a bigger increase in demand (at given price), and thus higher marginal revenue from quality, from patients with higher α. Patients with higher α have a marginal willingness to pay for a consultation and so, if they co-pay and are not bulk-billed, the price they pay increases with α.

3.2 Model predictions

We do not observe prices and quality for individual patients but we do have data (see section 4.1) on summary measures of GPs decisions:

a) the average price charged to patients who are not bulk-billed ($m+\bar{p}^{nb}$);
b) the proportion of each GP's patients who are bulk-billed $F^b=F(\alpha^b,\theta)$;
c) the average price charged to all patients ($\bar{p}=(F^b\times m)+(1-F^b)\left(m+\bar{p}^{nb}\right)=m+(1-F^b)\bar{p}^{nb}$;
d) the average quality of a GP ($\bar{q}$) (as measured by average consultation time for all her patients);
e) the number of patients seen per GP ($N=H/G$) (as measured by the number of consultations per week)

[7] $q_j(\alpha)$ is increasing and continuous in α (since $\mathrm{Lim}_{\alpha\to\alpha^b}q^b(\alpha)=\alpha^b/\delta$), though $\partial q_j(\alpha)/\partial\alpha$ is discontinuous at α^b.

We use the model to derive predictions about how these variables respond to an increase in the distance between GPs ($\ell = L/G$) which we interpret as a decrease in competition in the market. The first five columns in Table 1 summarise the comparative static properties of the model when the number of GPs (and hence ℓ) is fixed.[8] The table shows the ceteris paribus effects of changes in ℓ, m, δ, t, h, θ on the five variables we observe in our data.

[INSERT TABLE 1 HERE]

It is immediate from (8) that an increase in the distance between GPs (less competition) reduces the proportion of patients who are bulk-billed.

The effect of reduced competition on the average price to non-bulk-billed patients ($\overline{p}^{nb}$) is ambiguous. After a reduction in competition there are two groups of patients who pay a positive price (i.e. are not bulk-billed). The first group are those who were paying a positive price before the reduction in competition. The reduction in competition increases the price they face. The second group are those who were previously bulk-billed ie who faced a zero price. They now pay a positive price but because, they have a lower marginal valuation of quality than the first group, all of them pay less than the prices paid by the first group. If this second group is large enough the average price paid by the two groups could be reduced. If it is small enough the average price will be increased.

The average price paid across all patients is $\overline{p} = m + (1-F^b)\,\overline{p}^{nb}$ and this will increase when competition is reduced since the price for every patient is either increased or unchanged. Those patients who continue to be bulk-billed face an unchanged (zero) price. Patients who were previously bulk-billed now face a positive price, and those who were previously not bulk-billed pay a higher price than before.

Reduced competition leads GPs to reduce the quality provided to bulk-billed patients because quality is the only way to attract these patients. Competition has no effect on the quality they provide to non-bulk-billed patients. Thus average quality is reduced if there is less competition.

[8] The detailed derivations are in the Appendix.

The parameter θ shifts the distribution function of patient types. Increases in θ do not affect prices or quality for given types of patient but they do reduce the proportion who are bulk-billed. Our assumption that an increase in θ gives a first order stochastic dominating distribution of the willingness to pay for quality implies $F_\theta^b = F_\theta\left(\alpha^b(\ell,t,m,\delta);\theta\right) < 0$ so that the proportion of patients who are bulk-billed is reduced. First order stochastic dominance implies, since price is either constant or increasing in α and quality is increasing in α (see(6), (7)), that both $\overline{p}$ and $\overline{q}$ increase with θ. We can show that although the effect of θ on $\partial F^b / \partial \ell$ and $\partial \overline{p}^{nb} / \partial \ell$, are ambiguous, increases in θ make $\partial \overline{p} / \partial \ell$ more positive and $\partial \overline{q} / \partial \ell$ more negative. Thus in markets with higher θ a reduction in competition will lead to greater reductions in average quality and greater increases in average price.

Finally, an increase in ℓ increases the workload or number of patients seen by each GP. Because the market is covered, the workload of each GP is equal to the distance between GPs times the number of patients per unit of distance: $N = \ell h = (L/G)\ (H/L) = H/G$. Hence an increase in the distance between GPs or an increase in population density must increase workload.

3.3 Endogeneity of competition

We test for the effects of reduced competition (increased ℓ) by estimating cross-section regression models of the prices and qualities chosen by GPs in different markets with differing amounts of competition. However, in the absence of restrictions on entry, the number of GPs in a market and hence the distance between GPs (ℓ) is endogenous which raises the possibility that a simple cross-section model will produce biased estimates of the effect of ℓ.

With free entry into different markets, in equilibrium all markets will yield the same profit. Denote GP fixed cost of operating in the market by K (which can be taken to be a financial cost minus the monetary equivalent of any utility from the amenities in the market). Substituting the optimal patient price and quality from (6) and (7) into(3), maximised GP profit is

$$\pi^* = h\ell\int_{\alpha_0}^{\alpha_1}\left[p(\alpha;\ell,t,m,\delta) + m - \tfrac{1}{2}\delta q_i(\alpha;\ell,t,m,\delta)^2\right]dF(\alpha;\theta) = \pi^*(\ell;\delta,t,m,h,\theta) \quad (10)$$

The equilibrium number of GPs and hence the distance between GPs is determined by the condition that GPs break even:

$$\pi^*(\ell;\delta,t,m,h,\theta)-K=0 \qquad (11)$$

so that in equilibrium the distance between GPs is

$$\ell=\ell(\delta,t,m,h,K,\theta) \qquad (12)$$

Using the implicit function rule on **Error! Reference source not found.** the effects of δ, t etc on the equilibrium ℓ are $\partial\ell/\partial\delta = -\pi^*_\delta/\pi^*_\ell$ etc and these are reported in the rightmost column of Table 1.

Endogeneity of ℓ will lead to biased estimates of the effect of competition if the estimated model omits variables which determine prices or qualities and are correlated with ℓ. For example, the true model for the bulk-billing proportion is F^b = $F(\alpha^b(\ell,t,m,\delta);\theta)$ = $F^b(\ell(m,\delta,\theta,h,K),t,m,\delta,\theta)$. If the regression fails to include variables like θ which affect both F^b and ℓ positively, the estimated effect of ℓ on F^b will be positively biased. Omission of variables like t which only affect F^b and are not correlated with ℓ will not bias the estimated effect of ℓ, though it will lead to a loss of efficiency. Finally, variables like K which only affect F^b though their effect on ℓ should be omitted from the regression, though they could act as instruments for ℓ. We discuss the estimation of the regression models in more detail in section 4.2 after describing the data.

4 Empirical Methods

4.1 Data

We use data from the first wave of the Medicine in Australia: Balancing Employment and Life (MABEL) survey, a prospective cohort/panel study of workforce participation, labour supply and its determinants among Australian doctors. The sampling frame is the Australian Medical Publishing Company's (AMPCo) Medical Directory, a national database of all Australian doctors, managed by the Australian Medical Association (AMA). Data was collected from June to December 2008. The questionnaire covered topics such as job satisfaction and attitudes to work; characteristics of work setting (public/private hospital, private practice);

workload (hours worked, on-call); finances (income, income sources); geographic location; demographics; and family circumstances (partner and children) (Joyce et al, 2010).

The number of GPs responding in the first wave was 3906 (including 226 GP registrars (trainees)), a response rate of 19.36%. We restrict the study sample to GPs located in the major conurbations in Australia. The areas outside these conurbations are very sparsely populated and GPs in them face different financial incentives and regulations to those in our study sample. After excluding rural GPs and those with incomplete data we had a study sample of 1966 GPs. Our estimation sample is 12% of the population of 16,382 GPs in urban areas in Australia in 2008 (population data from the Australian Institute of Health and Welfare 2010). Our estimation sample averages are 47% female (population 40%), age 50.7 years (population 50.5), total hours worked 38.7 (population 37.7). Our sample over-represents female GPs, but in terms of age and working hours, our sample means are close to the population estimates from the AIHW.

Prices

The survey asks two questions about consultation fees. The first is "*Approximately what percentage of patients do you bulk bill/charge no co-payment?*" We use the answers to measure the proportion of patients who are bulk-billed (F^b).

The second question is "*What is your current fee for a standard (level B) consultation? (Include Medicare rebate and patient co-payment. Please write amount in dollars; write 0 if you bulk bill 100% of your patients)*". We use the answers to measure the average gross price ($\overline{p}^{nb} + m$) charged to patients who are not bulk-billed. We believe the answer to this survey question is a good measure of a GP's price setting behaviour since 88% of consultations in Australia are level B.

Quality

The GPs are asked *"How long does an average consultation last? (Please write number of minutes)"*. Since consultation length is positively correlated with measures of the quality of care including preventative care, lower levels of prescribing and some elements of patient satisfaction (Wilson and Childs 2002), we use this variable as a measure of the average quality of consultations ($\overline{q}$).

Workload

We use a variable measuring the number of patients each GP consults with as a proxy of the workload variable $N = H/G$ in the theory model. The survey question used is:

> "*In your most recent USUAL week at work, for around HOW MANY patients did you provide care? (Include new and existing patients in ALL SETTINGS—eg. hospital and private practice—procedures and telephone consultations for day time and out of hours)*"

Competition measure

There is a large literature on measuring competition in healthcare markets (Gaynor and Town, 2011). Studies on markets for hospital care often calculate Herfindahl-Herschmann indices (HHIs) based on market share information. Recent hospital market studies, such as Gaynor et al (2011), have used the approach of Kessler and McClellen (2000) and Gowrisankaran and Town (2003), to avoid the endogeneity problem that market share depends on a prices and qualities. These studies calculate the HHI from regression estimates of demand which include distance but not price or quality.

Studies in physician markets generally have not been able to take this approach (with the exception of Schneider et al, 2008) because of the absence of data on patients' residential location. Instead, most physician market studies have used physician density (physicians per capita in an area) (Bradford and Martin, 2000; Johar, 2012; Richardson et al, 2006; Savage and Jones, 2004). This approach has the disadvantage that all physicians in an area are assumed to face the same competitive pressure.

Since we only have information on the number of consultations with the GPs in our sample, we are unable to compute HHIs, from actual or estimated demand, as this would require information on patient distances from GPs and the volume of consultations for each GP, not just those in our sample. Instead we construct an individual GP level measure of competition: the distance between a GP's practice and her rival practices. This approach follows from the model in section 3 where we use distance between GPs (ℓ) as a measure of competition. Competition measures which are purely geographically defined have also been used in the hospital competition literature (Propper et al, 2004; Propper et al, 2008; Bloom et al, 2013). Recent industrial organisation literature has emphasised the importance of distance to competitors, rather than market share measures on pricing decisions (Thomadsen 2005, Alderighi and Piga 2012). Drawing on Bresnahan and Reiss (1991), who show that, in geographically isolated markets for professional services (including doctors and dentists) only the first three additional competitors in a market have a large effect on prices, we use the distance to the third nearest GP as our main measure of competition. We also investigate the robustness of the measure by estimating models using the distance to the nearest and 5th nearest GP practice.[9]

We construct the competition measures using data from AMPCo which covers the whole population of Australian GPs, not just those who responded to the MABEL survey. For each MABEL respondent we calculated the road distance from their practice to the nearest, third nearest, and fifth nearest other GP practice in the AMPCo data, whether or not the other practices were MABEL respondents.

GP and GP practice covariates

We use individual GP and GP practice characteristics to control for differences in costs or preferences which may influence pricing decisions. We include GP gender and whether they have a spouse or dependent children, as this may affect their marginal valuations of income and leisure. GPs who went to an Australian medical school (as opposed to graduating overseas) may be perceived by their patients to be better trained or to be easier to communicate with. GP experience (measured in ten year bands) may also affect demand as a proxy for quality. We know whether the GP is a partner or associate in a practice, rather than a salaried employee. Partners and associates share in the profits of the practice which may give them an incentive to charge higher prices. Partner or associate status also indicates seniority of the GP within the practice. We also control for the characteristics of the practice itself: practice size (number of GPs) and whether the practice is taxed as a company or not. Practice size

[9] We cannot tell from our dataset which of the 28% of GPs in practices taxed as companies are working for a firm owning a chain of practices. Distance to the third nearest practice would overstate the competitive pressure for such practices if practices belonging to the same chain were close together. We have mapped the location of the practices belonging to two chains in Melbourne. We find that for the eight practices in the Medical One chain the shortest distance to another practice in the chain is 3.7km, compared with the average distance to third nearest practice in our sample of 1.5km. For the 10 practices in the Healthscope chain the shortest distance is 3.5km. We think therefore that our competition measure is appropriate whether or not the practice belongs to a chain.

may influence pricing decisions either because of the effect of economies of scale on practice costs or incentive effects (Gaynor and Pauly, 1990). GPs working in a company may place a higher weight on profit.

Area characteristics

We also use data on area characteristics to capture other factors which may affect demand and cost conditions for GPs. We attribute them to GPs by their practice's location in postcode areas or Statistical Local Areas (SLAs). The 1966 GPs in the estimation sample are located in 616 postcode areas with an average population of 18,487. We use postcode area level data on the population age distribution, ethnicity, self-reported disability, and socio-economic status measured by the Socio-Economic Index for Areas (SEIFA). The SEIFA Index of Relative Socio-Economic Advantage and Disadvantage is constructed by the Australian Bureau of Statistics from 22 variables measuring education, income, occupational structure, employment status, and family structure. Higher values correspond to greater advantage and we expect postcodes with a higher SEIFA score to have greater valuation of quality and thus to have GPs who set higher prices and provide higher quality.

The GPs in the estimation sample are located in 402 SLAs with an average population of 33,164. We attribute SLA level data on median house prices and population density to GPs via their practice address. House prices may capture higher premise costs for GPs and richer populations who have a higher willingness to pay for GP services. In some SLAs there are additional incentives for bulk-billing and we include a dummy variable to indicate these SLAs.

Table 2 has descriptive statistics of the sample for all of the variables in the estimating equations.

4.1 Estimation

We estimate models for the proportion of patients who are bulk-billed F^b, the average gross price $\overline{p}^{nb}+m$ (which equals m when the GP bulk-bills all patients), the average gross price for all patients $m+\left(1-F^b\right)\overline{p}^{nb}$, the average consultation length $\overline{q}$, and the number of consultations per week N. We use log transformations $\ln(\overline{p}^{nb}+m)$, $\ln(m+\left(1-F^b\right)\overline{p}^{nb})$ for the price variables, quality $\ln(\bar{q})$, and workload $\ln(N)$ to allow for right skewness of the data and to yield coefficients as elasticities for ease of interpretation when explanatory variables are in log form.

Linear models

Our baseline model is a linear regression for GP j in area r

$$y_{jr} = \beta_0 + \beta_1 GPdist_{jr} + \beta_2 GPchars_{jr} + \beta_3 Areachars_r + \varepsilon_{jr} \qquad (13)$$

where y_{jr} is one of the five dependent variables. $GPdist_{jr}$ is a GP-practice specific measure of the distance between a GP and nearby practices, corresponding to ℓ in the theory model; $GPchars_{jr}$ is a vector of the characteristics of the GP and her practice; $Areachars_r$ are characteristics of the area in which the GP is located.

The variable of particular interest is $GPdist_{jr,}$ which we interpret from our theory model as measuring the degree of competition, a greater distance between GPs indicating less intense competition. Our first approach to identifying its effect is through variation in the outcomes y and competition *GPdist* across GPs j and areas r. We have a rich set of GP and practice characteristics but more limited area level information on patient characteristics which may shift demand. The key identification problem with this approach is related to GPs' ability to choose the area where they practice. If there are unobserved factors which affect their choice of location and are correlated with both y_{jr} and $GPdist_{jr}$, then the error term ε_{jr} will not be conditionally uncorrelated with $GPdist_{jr}$ thereby biasing the OLS estimate of β_1. For example, areas may differ in amenity. High amenity areas may attract more GPs and a population of patients who have a greater willingness to pay for consultations. Although we control for a range of area characteristics, they may not adequately capture all of these correlations. The estimated effect of distance between GPs on prices will then be biased downward.

Previous research has used area level characteristics, such as the supply of private schools, or expenditure on hotel services, or the proportion of the workforce who are professionals or managers, as instruments for GP supply (Richardson et al, 2006; Pauly and Sattertwhaite, 1981). But such characteristics may also make areas more attractive to patients with unobserved higher willingness to pay. A better alternative would be to exploit exogenous policy changes to provide a natural experiment or geographical variations in regulation, such as the varying degree of barriers to entry considered by Schaumans and Verboven (2008). However, there were no such exogenous changes or variations affecting the GPs in our study during the sample period.

Our preferred strategy for overcoming this problem is to take advantage of the fact that we have a measure of competition which is GP specific (distance to rival GPs) and thus varies both between areas (over *r*) and within areas (over *j* within *r*). There is an average of 4.7 GPs in each SLA in the estimation sample. We make use of this within-area variation in three ways: random area effects, fixed area effects, and Mundlak (1978) models. In the random effects model

$$y_{jr} = \beta_0 + \beta_1 GPdist_{jr} + \beta_2 GPchars_{jr} + \beta_3 Areachars_r + \gamma_r + \upsilon_{jr} \qquad (14)$$

γ_r is a N(0,σ^2) random variable. In the fixed effects specification we include the γ_r as parameters and the $Areachars_r$ are omitted from the model as they are perfectly collinear with the area fixed effects. The Mundlak (1978) specification is

$$y_{jr} = \beta_0 + \beta_1 GPdist_{jr} + \beta_2 GPchars_{jr} + \beta_3 Areachars_r + \lambda_1 \overline{GPdist}_r + \lambda_2 \overline{GPchars}_r + \gamma_r + \upsilon_{jr} \quad (15)$$

where γ_r is a N(0,σ^2) random effect and $\overline{GPdist}_r$, $\overline{GPchars}_r$ are the area means (for each *r*) of $GPdist_{jr}$ and $GPchars_{jr}$.

The area random effects specification will yield a consistent estimate of β_1 if the unobserved area effects γ_r are conditionally uncorrelated with $GPdist_{jr}$. The fixed effects estimation is consistent for β_1 if υ_{jr} is uncorrelated with $GPdist_{jr}$ given γ_r and $GPchars_{jr}$. The Mundlak specification is consistent if γ_r and υ_{jr} are uncorrelated with $GPdist_{jr}$ conditional on $GPchars_{jr}$, $\overline{GPdist}_r$, and $\overline{GPchars}_r$. This is more stringent than the requirement for fixed effects since the included area mean variables must capture the correlation between unobserved area characteristics and the GP varying characteristics (eg distance to other GP practices). The fixed effect estimator ensures all the unobserved area characteristics are picked up by the area effect γ_r.

Using the Mundlak or fixed effects specification means that we need sufficient within-area variation in both y_{jr} and $GPdist_{jr}$ areas to successfully identify β_1. The advantage of including area effects in the estimation is that it controls for characteristics of areas that would otherwise be unobserved but which may influence prices, including demand side influences not captured in the observed area level variables, and supply-side influences, such as the availability of other health services that may be substitutes for GP care (eg the number of pharmacies and emergency departments). We will obtain consistent estimates of the effect of *GPdist* on prices and quality provided that GP location decisions within areas are uncorrelated with within-area varying factors affecting pricing and quality decisions. This strategy works if doctors choose to practice in an area, such as a suburb, while their exact location within the area is determined by factors which do not influence their price and quality decisions, such as the availability of vacant premises for the setting up of a practice. We believe that the location of vacant premises and town planning restrictions are plausibly exogenous and uncorrelated with GP pricing and quality.

For the Mundlak and area fixed effects models ((14) and (15)) we use SLAs as the area, since there is more within-area variation than if we used the postcode as the area: there are an average of 4.9 GPs per SLA and 3.1 per postcode in the sample.

The areas (SLAs) in our empirical specification do not correspond precisely to the separate markets in the theory model. In the theory model we assume that all GPs in a market face the same amount of competition (i.e. they are the same distance apart) and so make the same choices about prices and quality. In the empirical specification our strategy for identifying the effect of competition requires that there is within-area variation in both distances between GPs and in price and consultation length. To link the theoretical markets and the empirical areas we could assume that the empirical areas are made up of separate markets (so that there is within-area variation in competition, prices, and quality) but that the non-demand factors (K in the theory model) affecting GP supply are similar across the markets within the area. Alternatively, we could assume that each area corresponds to a single market but that GPs do not locate equi-distant from each other because of the exigencies of geography and planning controls. [10]

[10] The assumption of equal spacing of GPs in the theory model is made for tractability since it is an extension of the Vickrey-Salop model to allow for price and quality discrimination and bulk billing. Key predictions about the effect of competition (measured by the distance between GPs) are likely to hold under more realistic assumptions about GP spacing. For example, it is possible to show that, in the basic price setting Vickrey-Salop specification but with unequally spaced GPs, a GP will have a higher Nash equilibrium price if she is located further away from her two neighbouring GPs.

Tobit model

The linear models do not make full use of the available data. When estimating the model for the average price to non-bulk-billed patients $\bar{p}_j^{nb}$ we ignore the information on the proportion of GP j's patients who are bulk-billed (F_j^b). From the model in section 3 (see equation(7)), the profit maximising net price p_i to patient i with taste α_i is $p_i = p^{nb}(\alpha_i;\cdot)$ if $\alpha_i \geq \alpha^b$ and $p_i = p^b(\alpha_i;\cdot) = 0$ if $\alpha_i < \alpha^b$, or $p_i = \max\{ p^{nb}(\alpha_i;\cdot), 0\}$. Thus, allowing for the variables determining the price to vary across GPs in different markets, the optimal net price to patient i of GP j is $p_{ij} = \max\{ p_j^{nb}, 0\}$, and the optimal gross price is $p_{ij} + m = \max\{ p_j^{nb} + m, m\}$.

Using the same log transform as in the linear model, we define

$$y_{ij} = \ln\left[\left(p_{ij} + m\right)/m\right] = \ln\left[\left(\max\{p_{ij}^{nb}, 0\} + m\right)/m\right] = \max\left\{y_{ij}^*, 0\right\} \qquad (16)$$

where $y_{ij}^* = \ln\left[\left(p_{ij}^{nb} + m\right)/m\right]$. If we had data on the gross prices charged to patient i of GP j we could estimate a Tobit model with log likelihood

$$\ln L_1 = \sum_j \sum_i^{S_j} \left\{ \left(1 - d_{ij}\right)\left[-\ln\sigma + \ln\phi\left(\frac{y_{ij} - x_j\beta}{\sigma}\right)\right] + d_{ij}\ln\left[1 - \Phi\left(\frac{x_j\beta}{\sigma}\right)\right]\right\} \qquad (17)$$

where $d_{ij} = 1$ if the patient is bulk-billed and $d_{ij} = 0$ otherwise, S_j patients are treated by GP j and $y_{ij} = \max\{y_{ij}^*, 0\} = \max\{x_j\beta + \varepsilon_{ij}, 0\}$ where ε_{ij} picks up all the unobserved patient i and GP j characteristics affecting the optimal price and is distributed $N(0,\sigma^2)$. Estimation of the model parameters β and σ would yield estimates of the effect of competition on the expected price to non-bulk-billed patients, the probability that a patient is bulk-billed, and the expected gross price.

Estimation using the log likelihood in (17) requires S_j observations of (y_{ij}, x_j) for each GP_j. However, we observe only the average price for non-bulk-billed patients $\bar{p}_j^{nb}$ and the proportion F_j^b who are bulk-billed. Assuming that all non-bulk-billed patients have the same price we can replace $y_{ij} = \ln((p_{ij} + m)/m)$ in **Error! Reference source not found.** with $y_j = \ln((\bar{p}_j^{nb} + m)/m)$ to get

$$\ln L_2 = \sum_j S_j \left\{ \left(1-F_j^b\right)\left[-\ln\sigma + \ln\phi\left(\frac{y_j - x_j\beta}{\sigma}\right)\right] + F_j^b \ln\left[1-\Phi\left(\frac{x_j\beta}{\sigma}\right)\right]\right\} \quad (18)$$

Making the further assumption that all GPs see the same number of patients ($S_j = S$), the values of β and σ which minimise (18) do not depend on S.

We use our data to create two observations for each GP of the form (y_j, x_j) = $\left(\ln\left(\left[\bar{p}_j^{nb} + m\right]/m\right), x_j\right)$ and $(0, x_j)$ with weights $(1-F_j^b)$ and F_j^b respectively and use the *tobit* command in Stata to estimate β and σ.

The vector of explanatory variable x is specified as in the linear model in equation (13). We also estimate a version of the Tobit with the Mundlak area-average terms as in equation (15).

If a GP sets different prices for different types of non bulk-billed patient, as in the theory model, the estimated Tobit model is a partial misspecification of the data generation process because we replace individual prices with average prices. In this case, the Tobit can be viewed as an alternative non-linear specification which makes better use of the available information than the separate linear models for prices and the bulk-billing rate.[11]

The estimates of β and σ yield estimates of three quantities of interest for each GP

(i) the bulk-billing probability

$$F_j^b = \Pr(y_j = 0 | x_j) = 1 - \Phi\left(x_j\beta/\sigma\right) \quad (19)$$

(ii) the expectation of $y_j = \ln\left(\left[\bar{p}_j^{nb} + m\right]/m\right)$ for non-bulk-billed patients

$$E[y_j \mid y_j > 0, x_j] = x_j\beta + \sigma\lambda(x_j\beta/\sigma) \quad (20)$$

where $\lambda(x_j\beta/\sigma) = \phi(x_j\beta/\sigma)/\Phi(x_j\beta/\sigma)$

(iii) the expectation of y_j for all patients $\left(\ln\left(\left[(\bar{p}_j + m\right]/m\right) = \ln\left(\left[\left(1-F_j^b\right)\bar{p}_j^{nb} + m\right]/m\right)\right)$

$$E[y_j | x_j] = \Pr(y_j > 0 \mid x_j)E[y_j \mid y_j > 0, x_j] = \Phi(x_j\beta/\sigma)\left[x_j\beta + \sigma\lambda(x_j\beta/\sigma)\right] \quad (21)$$

[11] Alternatively, it is possible to show that a theory model in which each GP sets the same price for all her non bulk-billed patients yields the same predictions about average prices as the individual level discrimination model. This alternative model is more involved than for the individual level discrimination model and is available from the authors.

We report the estimated average marginal effects of our competition measure, distance to competing practices, and other variables on these three different measures of GP price setting.

5 Results

Table 2 presents summary statistics. On average, the GPs in our sample bulk-bill (charge zero copayment to) 61 percent of their patients, 19.7 percent of GPs bulk-bill all of their patients and 1.6 percent of GPs bulk-bill none of their patients. Therefore close to 80 percent of GPs bulk-bill some but not all of their patients. The average gross price for all patients is $42.06. In comparison, national data from Medicare show an average gross price for all patients in 2008/9 of $42.80[12] for GP services. Our data show the average price for non-bulk-billed patients is $50.10. With a Medicare rebate of $32.80, this implies an average out of pocket payment of just under $18. In comparison, national Medicare data for 2008/9, which includes GPs in rural areas, shows that the average out of pocket payment for non-bulk-billed GP services was $21.50.

We have responses from 1966 GPs in 1417 different practices. GPs in the same practice do not appear to set the same price: the within practice standard deviation of the average price to non bulk-billed patients is $3.7 (compared to $11.6 in the overall sample) and the standard deviation of the within practice bulk billing rates is 9.8 percent (compared with 31.4 percent in the overall sample). This suggests that GPs within practices have different mixes of patients.

The average consultation time is 16.7 minutes and the average number of consultations per week is 111. The average distance to the third nearest other practice is 1.5 km which is more than twice the distance to the nearest practice and two thirds of the distance to the 5th nearest practice.

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[12] Medicare Statistics http://www.health.gov.au/internet/main/publishing.nsf/Content/medstat-jun12-tables-ba. Tables B1A and B2A (accessed 14 march 2014). These data are only available for all types of consultation (Level A-D), whilst our survey question refers to Level B consultations, which are the most common as they are 88% of all GP consultations.

The table shows considerable within-area variation in the key dependent variables and the competition measure. For example, for the average price variable, the standard deviation between areas is 7.9 and the standard deviation within areas is 7.2. These figures provide some justification for our strategy of exploiting within-area variation in the empirical analysis.

[INSERT TABLE 2 HERE]

Nearly half the GPs are female, which is similar to the proportion in other developed countries. Almost 20 percent are qualified overseas and most probably therefore not born in Australia. Just under a half of GPs are partners or associates and so have a direct financial interest in their practice. Only 14 percent work as single-handed GPs.

5.1 Average price to all patients

Linear Models

Table 3 presents detailed results for linear regression models where the dependent variable is the log of the gross price averaged over all patients seen by the GP: $\ln((1-F^b)\,\bar{p}^{nb} + m)$. All models in this and subsequent tables have standard errors corrected to allow for clustering at area (SLA) level.[13] The size and significance of the key results are similar across the four model specifications. A Hausman test comparing the area random and fixed effects models fails to reject the null of the random effects model for all four dependent variables (results available from authors).

[INSERT TABLE 3 HERE]

The first row in Table 3 reports the coefficients and SEs for our preferred measure of competition: the log of the distance to the third-nearest GP-practice. Since the dependent variable is also log-transformed, the coefficients on the distance measure are elasticity estimates. The coefficients are positive and statistically significant for all models: the greater the distance to

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[13] The 1966 GPs are located in 1379 practices. We also allowed for clustering at practice level but this made little difference to the standard errors.

the 3rd nearest practice, the higher the average price charged by the GP. The size of the effect is consistent across the alternative models, including the Mundlak and fixed effects models, which control for unobserved area-level characteristics.

Tobit models

Table 4 presents average marginal effects from two Tobit models of the average price to all patients in the practice. As in the linear models, the log transformation of the price measure means that the average marginal effects for the competition measure are average elasticities. The pattern of results is similar to the linear models but the estimated marginal effects of the competition measure are a little larger: 0.022 for the Tobit models compared to 0.018 for the equivalent linear models. This could be due to the Tobit models making better use of information on the non-trivial proportion (19.7%) of GPs who bulk-bill all patients.

[INSERT TABLE 4 HERE]

5.2 Bulk-billing, price to non-bulk-billed patients, quality and workload

Table 5 presents the estimates of the marginal effects of the competition measure on four other aspects of GP decisions: the proportion of patients bulk-billed F^b, the log of average price to those not bulk-billed ln($\overline{p}^{nb}$ +m), average quality $\overline{q}$ and workload N.

[INSERT TABLE 5 HERE]

The theory model predictions about the effect of competition on the average net price to bulk billed patients ($\overline{p}^{nb}$) are ambiguous but the estimated effect of greater distance to the third nearest rival is positive. The theory model predicts that the proportion of bulk billed patients will fall as this distance increases and the empirical results from all the empirical models support this. We saw in Table 3 and 4 that the average price to all patients [$\overline{p}^{nb}(1-F^b)$ + m] increased with the distance between GPs and the results in Table 5 suggest that just under two thirds of the effect arises from the reduction in the proportion who are bulk billed and one third from the increase in the price to those who are bulk billed.[14]

Greater distance to rivals is associated with lower average quality as measured by average consultation time. However, the estimated effects are small and have p values greater than 0.10. The modest estimated impact of competition on consultation length may be because the theory model suggests that competition will only affect the quality supplied to the 40% of patients who are not bulk-billed.

In the OLS and RE estimates distance to rivals is weakly negatively associated with workload (consultations per week). The association is statistically insignificant in the models with area Mundlak or fixed effects. The theory predicts a positive relationship because, like other papers employing the Vickrey-Salop model, we make the simplifying assumption that the market is covered so that we can focus on predictions about price and quality. If some patients are deterred from demanding a consultation by higher prices then less intense competition, which increases price, could also reduce workload.[15]

5.3 Effects of competition and patient socio-economic status

The theory model suggests that the effect of competition on the average price to all patients and on average quality will be greater in areas where there is a greater average willingness to pay for quality.[16] Table 6 reports the effects of distance to rival GPs and its interaction with

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[14] The elasticity of the average price with respect to distance is $\varepsilon^{\bar{p}} = \bar{p}^{nb}(1-F^b)(\bar{p})^{-1}\left(\varepsilon^{p^{nb}} + \varepsilon^{1-F^b}\right)$ and $\varepsilon^{\bar{p}^{nb}} / \left(\varepsilon^{\bar{p}^{nb}} + \varepsilon^{1-F^b}\right)$ is 0.36 using the Tobit Mundlak results

[15] It would be possible to extend the Vickrey-Salop model to the case where total demand is not fixed. For example, one could assume that GPs were distributed around the road and patients were distributed on and outside the circular road. Suitable choice of distance cost parameters and assumptions about the distribution of patients outside the circular road would yield an equilibrium in which GPs still compete (all patients on the road demand consultations) but the number of consumers outside the road demanding a consultation varies with the equilibrium price and quality.

[16] In the theory model this is captured by higher θ, a parameter which causes a first order stochastically dominating shift in the taste distribution function $F(\alpha;\theta)$.

the SEIFA advantage/disadvantage index. In the fixed effects and Mundlak models the interaction with the index of local area advantage is statistically significant in the models for average price to all patients and for bulk-billing. In all cases, the effects of distance to local competitors on the price or quality outcome is greater in areas of greater socio-economic advantage. Thus distance to local competitors has a stronger positive effect on average price to non-bulk-billed patients and on average price to all patients in advantaged areas, and a stronger negative effect on bulk-billing in more advantaged areas. The interaction term is not significant in the quality model, though the direct effect of distance to other GPs on consultation time is now slightly greater in all the linear models and significant in the fixed effect specification.[17]

[INSERT TABLE 6 HERE]

5.4 Effects of covariates

The effects of the covariates are consistent across the linear and non-linear (Tobit) models reported in Tales 3 and 4 and seem plausible. Female GPs set higher prices. This is perhaps because there is greater willingness to pay for a consultation with female GPs who may be perceived to have better interpersonal skills (Roter et al, 1991) or because female patients may prefer to consult female doctors. Reyes (2006) found that US female obstetricians/gynaecologists also charged higher fees than male obstetricians/gynaecologists.

GPs graduated from an Australian medical school also set higher prices, suggesting that consultations with them are regarded as being of higher quality. Patients are also willing to pay higher prices for GPs with more experience, except for those with over 40 years of experience. Partners or associates in practices set higher prices, presumably because they have a share in practice profits. There is only a weak effect of the size of the practice. GPs in areas with more advantaged patients set higher prices, suggesting that these patients have a higher willingness to pay.

[17] In all models we normalise the SEIFA index to have a mean of zero over the estimation sample. Thus in the linear models the average marginal effect of competition is given by the coefficient on on the competition measure (β_1).

Disabled patients are likely to have a higher demand for consultations (which should drive up the price) but are also likely to have lower incomes which should lower the price. The results suggest that the latter effect is dominant. GPs in areas with older patients set higher prices, possible because such patients have higher demands, higher incomes, and a greater cost of shopping around.

Areas with financial incentives to bulk-bill patients have higher prices, possibly reflecting that these incentives are inadequate to offset the factors that drive high prices (and low bulk-billing rates) in such areas. Prices are higher in areas with higher house prices, either because this reflects a greater willingness to pay of the local population or higher premise costs.

5.5 Robustness checks

Table 7 presents results for average price where we use alternative measures of localised competition as the key explanatory variable. Using the log of distance to the fifth nearest GP practice gives a larger marginal effect (approximately 50% larger) of distance on the average price. Using the log of distance to the nearest GP practice gives smaller estimates and with fewer statistically significant results than before. We attribute this to the lack of variation (evidenced by a smaller standard deviation) in this variable compared to the other distance measures.

[INSERT TABLE 7 HERE]

Table 8 has results of models for average price with different sets of covariates. The first row of the table contains models with the log distance to 3rd nearest practice as the only covariate. In the OLS and Tobit model with no controls and no area effects, the estimated coefficient is much smaller and insignificant. For models with area random effects, area Mundlak correction, and area fixed effects, the coefficient on log distance is similar to the models with a full set of controls. In the second set of models we add the GP and practice covariates but not the area-level covariates. Again, the models that do not account for area effects fail to find a statistically significant coefficient on the distance to nearby competitors, but with area effects, the models are similar to the full specification. In the full specification there is little difference in the key results between the models with and without area effects. The results in Table 8 demonstrate the importance of accounting for area effects. They also demonstrate that in the full specification, the area-level covariates pick up this important variation, hence explaining why there is little difference between the different model results.

[INSERT TABLE 8 HERE]

An assumption of our empirical approach is that unobserved factors correlated with distance and pricing decisions are captured by the area level covariates and area fixed effects. One possible mechanism that would violate this assumption is if GPs with observable characteristics which are less valued by patients, and which would tend to reduce the price they can charge, tend to locate further away from other GPs in the same area. We test for this possibility by regressing our competition measure, the log of the distance to the third nearest GP, on two characteristics of GPs likely to be valued by patients: GP experience and whether the GP qualified from an Australian medical school. The results, presented in Table 9, show that qualifying from an Australian medical school and experience as a GP are not associated with distance to nearby GPs.[18]

[INSERT TABLE 9 HERE]

We also estimated models in which quality was measured as the square root (instead of the log) of consultation length, as implied by the quadratic cost specification in the theory model. We find that the effect of log distance to the third nearest competitor is insignificant and of a similar magnitude to the original specification. Results are available on request.

6 Discussion

This paper develops theoretical and empirical models of the relationship between localised competition, measured by distance between GP practices, and price and quality setting in a market for General Practitioner services. Our approach follows a strand in the IO and hospital market literatures which emphasize distance to nearby competitors as a determinant of prices in general IO models (Alderighi and Piga, 2012; Thomadsen, 2005; Gaynor and Vogt, 2003).

[18] We also find no significant relationship between distance and proxies of GP quality in models which also include other GP characteristics and area variables. These results are available on request.

Our empirical results generally support the predictions from the theory model set out in Table 1. Our preferred measure of competition, distance to third-nearest GP practice, is significantly negatively associated with the proportion of patients who are bulk-billed F^b, positively associated with the average price to patients who are not bulk-billed $\bar{p}^{nb}$,and with the average price to all patients $\bar{p} = (1-F^b)\,\bar{p}^{nb}$.

Although all models yield qualitatively similar results, our preferred empirical specification is the Tobit model with the area-Mundlak adjustment. It combines the information on GP decisions on prices and the proportion of patients who are bulk-billed and allows for area level unobservables. This model yields a small estimated elasticity of 0.022 for the average price to all patients with respect to distance to third nearest GP. A one standard deviation (0.975) increase in the log distance to the third nearest GP practice implies a $0.90 increase in the average gross price and a 3.3 percentage point fall in the number of patients bulk-billed. Shifting a GP from the lowest decile of the distribution of distance to third nearest GP (0.29km) to the top decile (3.0km) is associated with $2.17 increase in the average price and a 7.9 percentage point reduction in the proportion of patients who are bulk-billed (ie face zero copayment).

We also find that in areas with higher socio-economic status, an increase in the distance to rival GP practices is associated with a larger increase in price and a larger reduction in the proportion of patients bulk-billed. This finding matches the prediction from our theoretical model that the average taste for quality in a market (θ), which we proxy with socio-economic status, increases the responsiveness of price to competition. The finding is also in line with Johar (2012) who finds the relationship between patient income and prices charged is larger in areas with higher GP density.

We interpret the results from the SLA fixed effects and Mundlak models as evidence of a causal effect of distance to nearby competitors on GP pricing decisions. We think it reasonable to assume factors affecting GP location and/or GP pricing operate across SLAs and not within them. In support of the assumption, we found no evidence that GPs with characteristics less valued by patients, and who would therefore have to charge lower prices, locate further away from other GPs in the same SLA (Table 9).

The fact that we find similar sized effects in models with and without area effects suggests that our area-level variables capture most area-level factors that are correlated with pricing decisions and our measures of competition. Our results are also broadly in agreement with previous studies of the Australian market using area-level data which find that higher GP density increases the bulk-billing rate (Richardson et al 2006, Savage and Jones 2004).

There has been increasing concentration in the market for GP services in Australia. Between 2003 and 2008, although the number of GPs in Australia grew by 4.6 percent the number of GP practices fell by 6.7 percent (Moretti et al 2010). Both state and federal government policy has encouraged the formation of larger practices, with current policy funding the establishments of 'GP Superclinics'. Increasing concentration could also be explained by a trend for private companies to own chains of large GP practices. There has also been an increase in concentration in the US (Liebhaber and Grossman, 2007). Our results suggest that the trends to increasing concentration in markets for physician services may lead to higher prices.

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Appendix. Derivation of comparative static results in Table 1

a) From (8) and (9), reductions in competition reduce the proportion of patients who are bulk-billed

$$\partial F^b / \partial \ell = f(\alpha^b, \theta) \partial \alpha^b / \partial \ell < 0 \tag{A1}$$

b) The effect of reduced competition on the average price charged to patients who are not bulk-billed ($\overline{p}^{nb}$) is

$$\frac{\partial \overline{p}^{nb}}{\partial \ell} = \frac{\partial \mathrm{E}\left[p(\alpha;\ell,t,m,\delta) \middle| \alpha \geq \alpha^b \right]}{\partial \ell} = \frac{\partial}{\partial \ell}\left[\int_{\alpha^b}^{\alpha_1} p(\alpha;\ell,t,m,\delta) f(\alpha,\theta) d\alpha \frac{1}{1-F(\alpha^b,\theta)} \right]$$

$$= \int_{\alpha^b}^{\alpha_1} \frac{\partial p(\alpha;\ell,t,m,\delta)}{\partial \ell} f(\alpha) d\alpha \frac{1}{1-f(\alpha^b,\theta)} - \frac{p(\alpha^b;\ell,t,m,\delta)}{1-F(\alpha^b,\theta)} \frac{\partial \alpha^b}{\partial \ell}$$

$$+ \int_{\alpha^b}^{\alpha_1} p(\alpha;\ell,t,m,\delta) f(\alpha) d\alpha \frac{1}{\left[1-F(\alpha^b,\theta)\right]^2} \frac{\partial F^b}{\partial \alpha^b} \frac{\partial \alpha^b}{\partial \ell}$$

$$= \int_{\alpha^b}^{\alpha_1} \frac{\partial p_i(\alpha;\ell,t,m,\delta)}{\partial \ell} f(\alpha,\theta) d\alpha \frac{1}{1-F(\alpha^b,\theta)}$$

$$+ \int_{\alpha^b}^{\alpha_1} p(\alpha;\ell,t,m,\delta) f(\alpha,\theta) d\alpha \frac{1}{\left[1-F(\alpha^b,\theta)\right]^2} f(\alpha^b,\theta) \frac{\partial \alpha^b}{\partial \ell} \tag{A2}$$

The first term in the last line is positive but the second is negative since α^b is decreasing in ℓ (less competition reduces the threshold type at which the GP sets a positive price). Intuitively, reductions in competition increase the price for those already facing a positive price (the first term) but dilutes the average price to paying patients because of those patients who were previously not charged (ie were bulk-billed) and who now pay but face a low price (the second term). If there are sufficient of these payers the average price for those not bulk-billed will fall.

c) The effect of ℓ on average quality for all patients ($\overline{q}$) is, from (6) and(7),

$$\frac{\partial \overline{q}}{\partial \ell} = \int_{\alpha_0}^{\alpha^b} \left[\left((\delta \ell t)^2 + 2\alpha^2 \delta m \right)^{-\frac{1}{2}} \ell \left(\delta t \right)^2 - \delta t \right] f(\alpha,\theta) d\alpha$$

$$= \int_{\alpha_0}^{\alpha^b} \left((\delta \ell t)^2 + 2\alpha^2 \delta m \right)^{-\frac{1}{2}} \delta t \left[\delta \ell t - \left((\delta \ell t)^2 + 2\alpha^2 \delta m \right)^{\frac{1}{2}} \right] f(\alpha,\theta) d\alpha < 0 \tag{A3}$$

where we use the fact that quality for bulk-billed patients is positive so that the square bracketed term in the second line is negative from(6).

d) The effect on average net price $\overline{p} = \left(1 - F^b\right)\overline{p}^{nb}$ is

$$\frac{\partial \overline{p}}{\partial \ell} = \frac{\partial \mathrm{E}\left[\, p(\alpha;\ell,t,m,\delta) \middle| \alpha \geq \alpha^b \,\right]\left[1 - F(\alpha^b,\theta)\right]}{\partial \ell}$$

$$= \frac{\partial}{\partial \ell}\left[\int_{\alpha^b}^{\alpha_1} p(\alpha;\ell,t,m,\delta) f(\alpha,\theta) d\alpha \frac{1}{1 - F^b(\alpha^b,\theta)}\right]\left[1 - F^b(\alpha^b,\theta)\right]$$

$$= \frac{\partial}{\partial \ell}\int_{\alpha^b}^{\alpha_1} p(\alpha;\ell,t,m,\delta) f(\alpha,\theta) d\alpha$$

$$= \int_{\alpha^b}^{\alpha_1} t f(\alpha,\theta) d\alpha - p(\alpha^b;\ell,t,m,\delta)\frac{\partial \alpha^b}{\partial \ell} > 0 \qquad \text{(A4)}$$

Table 1. Comparative static properties

Increase in	Ceteris paribus effect on prices, bulk-billing, quality, workload $\overline{p}^{nb}$	F^b	$\overline{p}$	$\overline{q}$	N	Effect on distance between GPs (ℓ) with entry
ℓ	?	–	+	–	+	NA
t	?	–	+	–	0	0
m	–	+	+	+	0	–
δ	–	+	–	–	0	+
θ	+	–	+	+	0	–
h	0	0	0	0	+	–
K	0	0	0	0	0	+

$\overline{p}^{nb}$: average net price (excess over Medicare reimbursement m) paid by patients who are not bulk-billed; F^b: proportion of patients who are bulk-billed (pay nothing out of pocket); $\overline{p} = (1 - F^b)\,\overline{p}^{nb}$: average over all patients of net price paid (in excess over Medicare fee m); $\overline{q}$: average quality (consultation length); N : consultations per GP; ℓ : distance between GPs; t: patient travel cost; m: Medicare reimbursement; δ : quality cost parameter; θ : shift parameter for distribution of patient marginal valuation of quality (higher θ implies higher average valuation); K: GP fixed costs net of value of local amenities.

Table 2. Summary statistics

	Mean	SD overall	Min	Max	SD between and within areas	
Dependent Variables					Between (n=402)	Within (n=4.89)
Av price all patients: $m + (1\text{-}F^b)\ \overline{p}^{nb}$	42.063	9.712	32.800	150.000	7.947	7.206
Patients bulk-billed (%): F^b	60.95	31.43	0.00	100.00	24.40	23.92
Bulk-billed zero patients (%)	0.016	0.127	0.000	1.000		
Bulk-billed all patients (%)	0.197	0.398	0.000	1.000		
Av price to non-bulk-billed: $\overline{p}^{nb} + m$	50.11	11.61	32.80	150.00	8.88	8.86
Consult time (mins)	16.68	5.63	5.00	60.00	3.50	4.93
Number of consults/week	111.3	60.7	1.0	560.0	40.2	51.5
Competition Variables						
Closest GP Practice (km)	0.696	0.988	0.000	9.434	1.106	0.613
Third closest GP practice (km)	1.519	1.592	0.003	17.448	1.748	0.904
Ln(Third closest GP practice (km))	0.002	0.975	-5.954	2.859	0.835	0.602
Fifth closest GP practice (km)	2.166	1.977	0.067	19.005	2.232	0.959
GP and Practice Variables						
Female GP	0.472	0.499	0.000	1.000		
Spouse	0.867	0.339	0.000	1.000		
Children	0.640	0.480	0.000	1.000		
Australian Medical School	0.814	0.389	0.000	1.000		
Experience 10-19 years	0.208	0.406	0.000	1.000		
Experience 20-29 years	0.366	0.482	0.000	1.000		
Experience 30-39 years	0.265	0.441	0.000	1.000		
Experience 40+ years	0.092	0.289	0.000	1.000		
GP registrar	0.035	0.183	0.000	1.000		
Partner or associate	0.455	0.498	0.000	1.000		
Practice taxed as company	0.276	0.447	0.000	1.000		
Practice size: 2-3 GPs	0.169	0.375	0.000	1.000		
Practice size: 4-5 GPs	0.200	0.400	0.000	1.000		
Practice size: 6-9 GPs	0.326	0.469	0.000	1.000		
Practice size: 10+ GPs	0.160	0.366	0.000	1.000		
Area Variables						
SEIFA Index of adv/disadv	0.000	1.000	-4.521	2.242		
Incentive area	0.228	0.420	0.000	1.000		
Median House price ($0,000)	55.522	29.379	16.550	302.250		
Proportion of residents U15	0.177	0.048	0.025	0.293		
Proportion 65+	0.134	0.045	0.023	0.309		
Proportion disabled	0.039	0.014	0.006	0.091		
Proportion NW Europe	0.082	0.040	0.011	0.269		
Proportion SE Europe	0.049	0.042	0.005	0.301		
Proportion SE Asia	0.042	0.051	0.002	0.422		
Proportion Other	0.096	0.082	0.002	0.496		
Popn density (pop/km2) ('000)	2.047	1.609	0.019	8.757		

Note: Descriptive statistics for estimation sample of 1966 GPs. Area variables are measured at SLA level for the incentive area dummy, population density and median house prices, and at postcode level for all others. For the regression models we standardise the SEIFA variable to have a zero mean and standard deviation of one. For dependent and competition variables, the standard deviations are also given for ‘between’ and ‘within’ areas (SLAs)

Table 3: Linear models of average price to all patients

	OLS		R.E.		Mundlak		F.E.	
Explanatory Variable	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
ln(3rd closest GP pr)	0.018	0.005 ***	0.018	0.005 ***	0.018	0.007 ***	0.017	0.006 ***
Female GP	0.041	0.010 ***	0.041	0.010 ***	0.041	0.011 ***	0.040	0.011 ***
Spouse	0.005	0.012	0.009	0.012	0.011	0.013	0.014	0.013
Children	0.006	0.010	0.005	0.010	0.005	0.010	0.008	0.010
Australian Medical School	0.074	0.010 ***	0.071	0.010 ***	0.069	0.012 ***	0.070	0.012 ***
Experience 10-19 years	0.042	0.019 **	0.042	0.018 **	0.042	0.019 **	0.041	0.019 **
Experience 20-29 years	0.026	0.018	0.028	0.017	0.034	0.018 *	0.032	0.019 *
Experience 30-39 years	0.028	0.019	0.033	0.018 *	0.040	0.019 **	0.040	0.020 **
Experience 40+ years	-0.024	0.020	-0.018	0.019	-0.005	0.021	-0.005	0.021
Registrar	-0.008	0.021	0.001	0.021	0.013	0.021	0.011	0.021
Partner or associate	0.038	0.010 ***	0.038	0.010 ***	0.037	0.011 ***	0.037	0.011 ***
Company	0.012	0.010	0.008	0.009	0.004	0.010	0.004	0.010
Practice size: 2-3 GPs	-0.012	0.016	-0.012	0.015	-0.011	0.016	-0.012	0.016
Practice size: 4-5 GPs	0.019	0.016	0.024	0.016	0.034	0.018 *	0.032	0.018 *
Practice size: 6-9 GPs	0.032	0.014 **	0.030	0.014 **	0.030	0.015 *	0.030	0.016 *
Practice size: 10+ GPs	0.027	0.017	0.023	0.017	0.018	0.018	0.011	0.019
SEIFA adv/disadv	0.038	0.013 ***	0.035	0.013 ***	0.035	0.013 ***		
Incentive Area	0.042	0.016 ***	0.040	0.017 **	0.040	0.016 **		
Median house price	0.001	0.000 ***	0.001	0.000 ***	0.001	0.000 ***		
Percentage U15	-0.554	0.177 ***	-0.525	0.186 ***	-0.520	0.186 ***		
Percentage 65+	0.239	0.202	0.304	0.200	0.311	0.194		
Percentage disabled	-0.799	0.814	-1.026	0.809	-1.021	0.804		
Percentage NW Europe	0.013	0.184	-0.047	0.188	-0.057	0.198		
Percentage SE Europe	-0.548	0.184 ***	-0.468	0.189 **	-0.472	0.191 **		
Percentage SE Asia	0.201	0.170	0.104	0.173	0.092	0.173		
Percentage Other	0.067	0.107	0.105	0.107	0.119	0.106		
Pop per km2	-0.001	0.005	-0.002	0.005	-0.003	0.005		
State dummies	Yes		Yes		No		No	
Local area random effects	No		Yes		Yes		No	
Local area averages	No		No		Yes		No	
Local Area FE's	No		No		Yes		Yes	
Obs	1966		1966		1966		1966	
R-squared	0.289		0.287		0.297		0.078	

Notes: Dependent variable is $\ln(\overline{p}) = \ln[m + (1\text{-}F^b)\,\overline{p}^{nb}]$ where m is the Medicare rebate, $\overline{p}^{nb}$ is the average price to patients who are not bulk-billed and F^b is the proportion of patients who are bulk-billed. Standard errors adjusted for clustering at SLA level. *: p < 0.10, **: p< 0.05; ***: p < 0.01 (two tailed). All regression models include a constant term.

Table 4: Tobit models of average price to all patients

	Tobit		Tobit with Mundlak	
Explanatory Variable	Marg eff.	S.E.	Marg eff	S.E.
ln(3rd closest GP pr)	0.022	0.006 ***	0.022	0.007 ***
Female GP	0.041	0.009 ***	0.042	0.010 ***
Spouse	0.013	0.012	0.019	0.012
Children	0.003	0.010	0.002	0.010
Australian Medical School	0.091	0.013 ***	0.087	0.014 ***
Experience 10-19 years	0.038	0.019 **	0.046	0.019 **
Experience 20-29 years	0.024	0.019	0.040	0.019 **
Experience 30-39 years	0.025	0.019	0.043	0.019 **
Experience 40+ years	-0.032	0.022	-0.003	0.022
Registrar	-0.007	0.023	0.017	0.022
Partner or associate	0.040	0.010 ***	0.037	0.011 ***
Company	0.011	0.010	0.005	0.010
Practice size: 2-3 GPs	-0.003	0.016	0.000	0.017
Practice size: 4-5 GPs	0.027	0.016 *	0.042	0.018 **
Practice size: 6-9 GPs	0.035	0.014 **	0.034	0.015 **
Practice size: 10+ GPs	0.026	0.017	0.016	0.018
SEIFA adv/disadv	0.048	0.011 ***	0.045	0.011 ***
Incentive Area	0.046	0.015 ***	0.045	0.015 ***
Median house price	0.001	0.000 ***	0.001	0.000 ***
Percentage U15	-0.560	0.166 ***	-0.574	0.169 ***
Percentage 65+	0.311	0.192	0.345	0.184 *
Percentage disabled	-1.080	0.732	-1.224	0.724 *
Percentage NW Europe	-0.109	0.177	-0.156	0.181
Percentage SE Europe	-0.582	0.214 ***	-0.566	0.214 ***
Percentage SE Asia	0.055	0.184	0.008	0.181
Percentage Other	0.067	0.113	0.092	0.112
Pop per km2	0.000	0.004	-0.001	0.004
State dummies	Yes		Yes	
Local area random effects	No		No	
Local area averages	No		Yes	
Local Area FE's	No		No	
Obs	1966		1966	
Pseudo - R2	0.010		0.104	

Dependent variable: $\ln[m + (1\text{-}F^b)\,\overline{p}^{nb}/m] = \ln[m+(1-F^b)\overline{p}^{nb}] - \ln m$. The observations are weighted by the proportion of patients who are bulk-billed, as described in section 4. Average marginal effects are reported. Standard errors adjusted for clustering at SLA level.

Table 5: Effects of competition (log distance to 3rd nearest GP) on price to non bulk-billed patients, bulk billing rate, quality, and workload

	OLS		R.E.		Mundlak		F.E.		Tobit		Tobit with Mundlak	
Dependent Variable	Coef	S.E.	Coef	S.E.	Coef	S.E.	Coef	S.E.	Marg eff	S.E.	Marg eff	S.E.
Log average price to non-bulk-billed patients: $\ln(\bar{p}^{nb} + m)$	0.019	0.008 **	0.018	0.008 **	0.019	0.011 *	0.018	0.011 *	0.017	0.004 ***	0.017	0.005 ***
Bulk-billing rate: F^b	-3.009	0.800 ***	-2.945	0.762 ***	-3.159	0.959 ***	-3.090	0.940 ***	-3.265	0.832 ***	-3.369	0.106 ***
Log of consult time: $\ln(\bar{q})$	-0.007	0.008	-0.007	0.008	-0.015	0.011	-0.016	0.011	N/A		N/A	
Log of consultations/week: $\ln(N)$	-0.029	0.017 *	-0.030	0.017 *	-0.030	0.023	-0.027	0.022	N/A		N/A	

Notes: Table reports coefficients for linear models, and average marginal effects for Tobit models, of log distance to the 3rd closest other GP practice. Each coefficient and standard error represents a different model estimation. Models also contain covariates in full models reported in Tables 3 and 4. *: p < 0.10, **: p< 0.05; ***: p < 0.01 (two tailed).

Table 6: Average marginal effects of competition on price and quality: interaction with socio-economic status

Dependent Variable	OLS		R.E.		Mundlak		F.E.	
Explanatory variables	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Dep Var: log ave price to non bulk-billed: $\ln(m+\bar{p}^{nb})$								
ln(3rd closest GP)	0.017	0.008 **	0.017	0.008 **	0.021	0.011 **	0.022	0.011 **
ln(3rd closest GP)*SEIFA	-0.004	0.007	-0.002	0.007	0.009	0.009	0.012	0.009
Dep Var: bulk-billing rate F^b								
ln(3rd closest GP)	-3.105	0.886 ***	-3.225	0.838 ***	-3.713	1.023 ***	-3.783	1.011 ***
ln(3rd closest GP)*SEIFA	-0.301	0.800	-0.830	0.745	-1.738	0.872 **	-2.177	0.858 **
Dep Var: log average price $\ln\left[m+(1-F^b)\bar{p}^{nb}\right]$								
ln(3rd closest GP)	0.018	0.006 ***	0.018	0.006 ***	0.021	0.007 ***	0.021	0.007 ***
ln(3rd closest GP)*SEIFA	-0.002	0.005	0.001	0.005	0.008	0.006	0.012	0.006 **
Dep var: log consult time $\ln(\bar{q})$								
ln(3rd closest GP)	-0.005	0.007	-0.005	0.007	-0.014	0.011	-0.060	0.011 ***
ln(3rd closest GP)*SEIFA	0.008	0.007	0.008	0.007	0.001	0.011	-0.001	0.011

Notes: Table reports coefficients for linear models of log distance to the 3rd closest other GP practice and its interaction with SEIFA an index higher values of which correspond to higher socio-economic advantage. Models also contain covariates in full models reported in Tables 3 and 4. *: p < 0.10, **: p< 0.05; ***: p < 0.01 (two tailed).

Table 7: Effect of competition on average price to all patients: alternative measures of competition

Dep Var: log average price = $ln[m+ (1-F^B)* \bar{p}^{nb}]$	OLS		R.E.		Mundlak		F.E.		Tobit		Tobit with Mundlak	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Marg eff	S.E.	Marg eff	S.E.
ln(closest GP pr)	0.007	0.003 **	0.006	0.003 **	0.006	0.003 *	0.005	0.003	0.009	0.003 ***	0.007	0.004 **
ln(3rd closest GP pr)	0.018	0.005 ***	0.018	0.005 ***	0.018	0.007 ***	0.017	0.006 ***	0.022	0.006 ***	0.022	0.007 ***
ln(5th closest GP pr)	0.027	0.008 ***	0.026	0.007 ***	0.031	0.009 ***	0.029	0.009 ***	0.033	0.008 ***	0.038	0.011 ***

Notes: dependent variable is log of average price $\ln[m+(1-F^b)\,\bar{p}^{nb}]$. Each coefficient and standard error represents a different model estimation. Models also contain covariates in the models reported in Tables 3 and 4. *: p < 0.10, **: p< 0.05; ***: p < 0.01 (two tailed).

Table 8: Effect of competition on average price to all patients: alternative sets of covariates

Dep Var: log average price = $ln[m+ (1-F^B)* \bar{p}^{nb}]$	OLS		R.E.		Mundlak		F.E.		Tobit		Tobit with Mundlak	
	Coeff.	S.E.	Coeff.	S.E	Coeff.	S.E.	Coeff.	S.E.	Marg eff	S.E.	Marg eff	S.E.
ln(3rd closest GP pr) with no other covariates[1]	0.005	0.008	0.013	0.005***	0.018	0.007**	0.018	0.007**	0.008	0.008	0.021	0.007***
Only GP and practice covariates[2]	0.004	0.007	0.012	0.005**	0.017	0.006***	0.017	0.006***	0.008	0.007	0.020	0.007***
Full specification[3]	0.018	0.005***	0.018	0.005***	0.018	0.007***	0.017	0.006***	0.022	0.006***	0.022	0.007***

Notes: dependent variable is log of average price $\ln[m+(1-F^b)\,\bar{p}^{nb}]$. Each coefficient and standard error represents a different model estimation. [1] Models include constant, ln distance to 3rd nearest practice. The RE and FE models include random and fixed area effects and the Mundlak models include the area mean of the distance variable. [2]Models are as in previous case but with the addition of the GP and practice covariates but with no area level covariates. [3]Full specification as reported in tables 3 and 4. *: p < 0.10, **: p< 0.05; ***: p < 0.01 (two tailed).

Table 9: Regressions of log distance to competitors on proxies of GP quality

	OLS		R.E.		Mundlak		F.E.	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Australian Medical School	-0.037	0.073	0.005	0.055	0.031	0.057	0.031	0.057
Experience 10-19 years	0.076	0.117	0.020	0.077	0.008	0.078	0.008	0.078
Experience 20-29 years	-0.002	0.110	-0.012	0.081	-0.014	0.083	-0.014	0.083
Experience 30-39 years	0.078	0.119	-0.009	0.075	-0.027	0.076	-0.027	0.076
Experience 40+ years	0.012	0.115	0.019	0.092	0.020	0.095	0.020	0.095

Notes: Dependent variable: log distance to 3rd nearest GP practice. Standard errors adjusted for clustering at SLA level. *: $p < 0.10$, **: $p < 0.05$; ***: $p < 0.01$ (two tailed). All regression models also include a constant but no covariates.